The Effects of Prediction and Speech Rate on Lexical Processing

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Introduction

We not only process language as we hear it, but also predict what we are likely to hear next. That is, listeners/readers use previous knowledge and context to constrain the possible outcomes of an incoming sentence. This prediction may increase processing efficiency and facilitate comprehension.[1]

Questions:

- Is prediction *always* good? What about when people make the wrong prediction?
  - We don't know because most past work focuses on highly predictable words that are probably accurately predicted
- What factor(s) aside from sentence context influence how easy it is to make predictions?
  - Non-linguistic differences in the input such as speech rate?
  - Individual differences in listeners such as working memory and processing speed?

Hypotheses

Question 1: How does correct, incorrect, or no prediction influence language processing time?

- **Option 1:** Prediction may facilitate processing for the predicted word *and* different similar words
- **Option 2:** Prediction may facilitate processing for the predicted word *but interfere* with processing of different similar words.
- **No Effect**: Active prediction may not facilitate language processing in sentences of moderate predictability.

Question 2: How might fast, medium, and slow speech rate influence prediction, and thus language processing time?

- **Option 1:** Prediction and language processing require more time as speech rate increases and less time as speech rate decreases
- **Option 2:** Prediction and language processing occur faster as speech rate increases, and slower as speech rate decreases
- **Option 3:** Speed of language processing at fast and slow speech rates differs for incorrect and correct predictions.

Question 4: How might individual differences in Processing Speed and Working Memory affect these effects on language processing time?

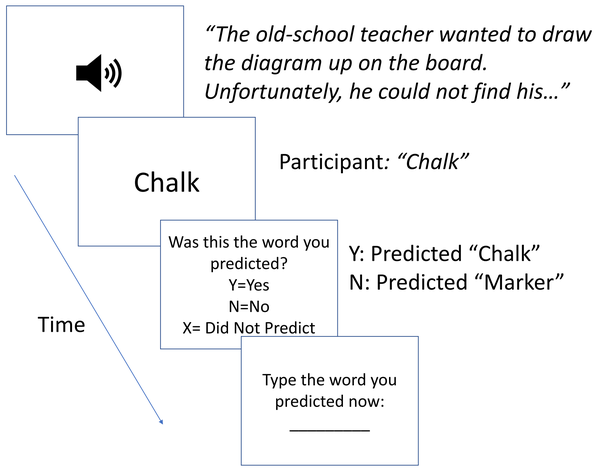
Methods and Materials

Main Experiment:
42 participants were instructed to actively predict the final word while listening to 145 two-sentence passages[2] at fast rate, med rate or slow rate. After a 250ms pause, the final word appeared on the screen, and they were instructed to say this word The sentences are designed so that the target word is one of two equally likely final words.

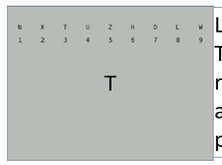
To ensure that participants were actively predicting, 35 filler trials ended in a blank on the screen instead of a word, in which participants needed to generate their own response.

Individual Differences on Cognitive Measures:
1. General Processing Speed Measures: Letter Digit Span, Visual Search
2. Working Memory Measures: Operation Span, Backward Digit Span

Main Task Overview:

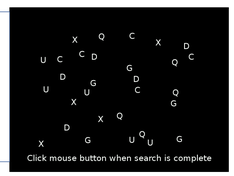


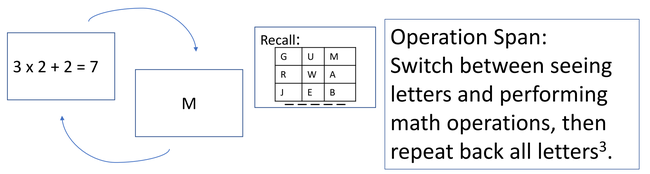
Individual Differences



Letter-Digit Substitution: Type the corresponding number based on the key at the top as quickly as possible[3].

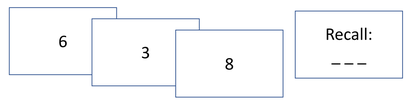
Visual Search: Search for the letter X in an array of letters on the screen. Then click on the location of the letter[3].



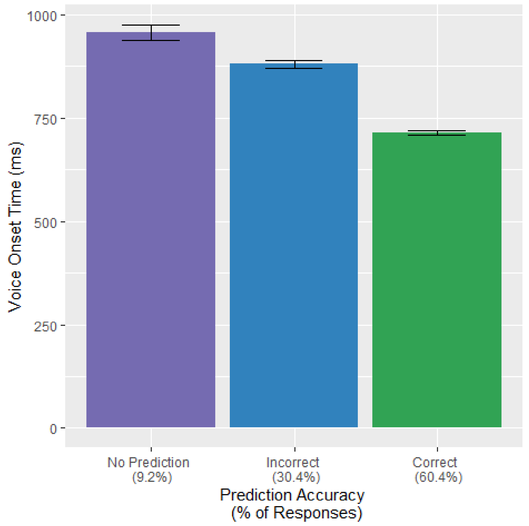


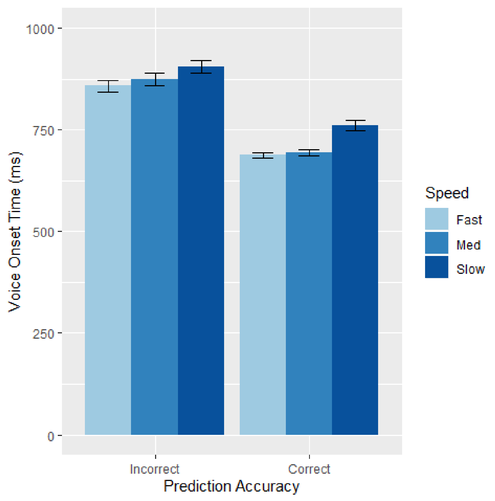
Operation Span: Switch between seeing letters and performing math operations, then repeat back all letters[3].

Backward Digit Span: Repeat a series of digits in backward order[3].



Results





Question 1: Correct prediction yields the fastest response time, and incorrect prediction yields a faster response time than no prediction (Option 1)

Prediction facilitates processing speed for the predicted word and, to a lesser extent, another word that also fits the context.

Question 2: Slow speech rate results in increased response time. Participants respond slower when listening to a slower speech rate (Option 2)

Listeners may adjust their prediction speed using cues from speech rate, so when speech rate is faster they automatically predict faster

Individual Differences Results: There was no relationship between prediction accuracy or speech rate effects with either general processing speech or working memory. This may be explained by the small sample size.

Discussion

- Correct and incorrect prediction both facilitate language processing time compared to no prediction
  - Active prediction of linguistic information is beneficial for language comprehension.
  - Correct prediction lexically facilitates target word
  - Incorrect prediction semantically facilitates target word
- Participants increase language processing speed when listening to language spoken at a faster rate regardless of prediction accuracy.
  - listeners use external cues to predict the same information at different rates, and rapidly use it to process language.
- General Processing Speed and Working Memory were not related to these results
  - Effect may not have been detected because of a small sample size.

References

1. Kuperberg, G. R., & Jaeger, T. F. (2016). What do we mean by prediction in language comprehension *? 3798*. https://doi.org/10.1080/23273798.2015.1102299
2. Brothers, T., Swaab, T. Y., & Traxler, M. J. (2015). Effects of Prediction and Contextual Support on Lexical Processing: Prediction Takes Precedence. *Cognition*, *136*, 135–149. https://doi.org/10.1016/j.cognition.2014.10.017
3. Mueller, S. T., & Piper, B. J. (2014). The Psychology Experiment Building Language (PEBL) and PEBL Test Battery. Journal of neuroscience methods (222), 250–259.